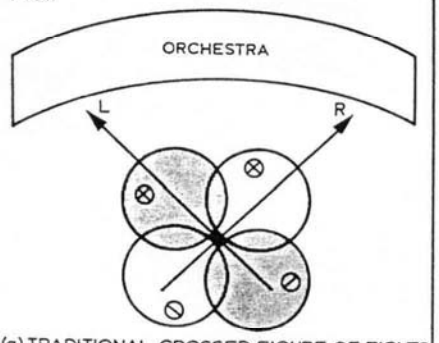
A PHASED ARRAY

by Tony Faulkner

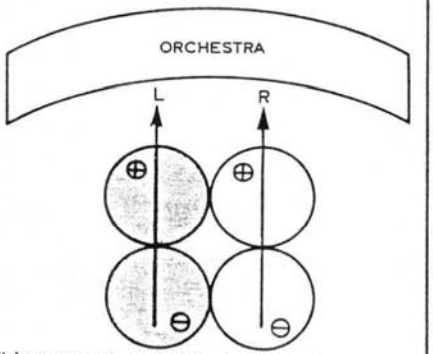
AS A FULL-TIME professional sound-recording engineer, I find myself continually bombarded with 'helpful advice' from magazine articles on individual authors' ideas about the only way one should make recordings. Few practising engineers have time to put pen to paper, and the resultant vacuum is filled by an unholy mixture of omniscient academics, critics and amateurs, whose contributions seem too often to bear little if any relation to the real world of classical music recording. The problem is that neither the academic, the critic, nor the amateur has basic aims similar to those of the professional engineer, whose function is to deliver to the general marketplace the overall aural impression of a musical performance. The academic has one apparent object in mind, the ratification at all costs of his mathematical models and formulae, whereas the amateur has the distinct advantage of having only to satisfy a limited market, usually of one, himself.

Alan Blumlein's patent (BP394325, application date: December 14th 1931) was the first major (and probably remains the most helpful) examination of stereophony, and I find it sad that in commercial terms not only did most of his ideas remain just on paper for close on 30 years, but the theories have not since been developed in the light of the wealth of practical experience of so many engineers. In common with many other recordists I have great sympathy with the idea of using two coincident figure-of-eight microphones angled at 90° relative to each other (fig.1a) and I have used this technique with varying success on many occasions. Nonetheless, I must say that it is unsatisfactory for a large proportion of commercial work for several reasons, the principal one arising out of a well-known physical law called the inverse square law. When recording an orchestra in an empty concert-hall, for example, a great deal of ambience is picked up by the rear-lobes of the mikes, which are equal in sensitivity, of course, to the front lobes. This means that in order to reproduce a desirable live-to-reverberant ratio in the reproduced sound, it is necessary to move the microphones closer to the orchestra than one would anticipate. As one moves closer, two adverse side-effects become more significant; firstly the stereo image becomes spectacularly overwide, and secondly the musical balance is distorted by virtue of the inverse-square law, which will favour the instruments closest to the microphones once the sampled path-difference ratio deviates significantly from the far-field ratio which would be perceived by a typical member of the audience (fig. 2). The usual way out is to reinstate the musical balance by raising the microphones, but this can produce an edgy string quality and also removes the 'anchoring' quality of a familiar floor reflection at the bass end, leaving the listener with a sensation of being up in mid-air.

FIG.1

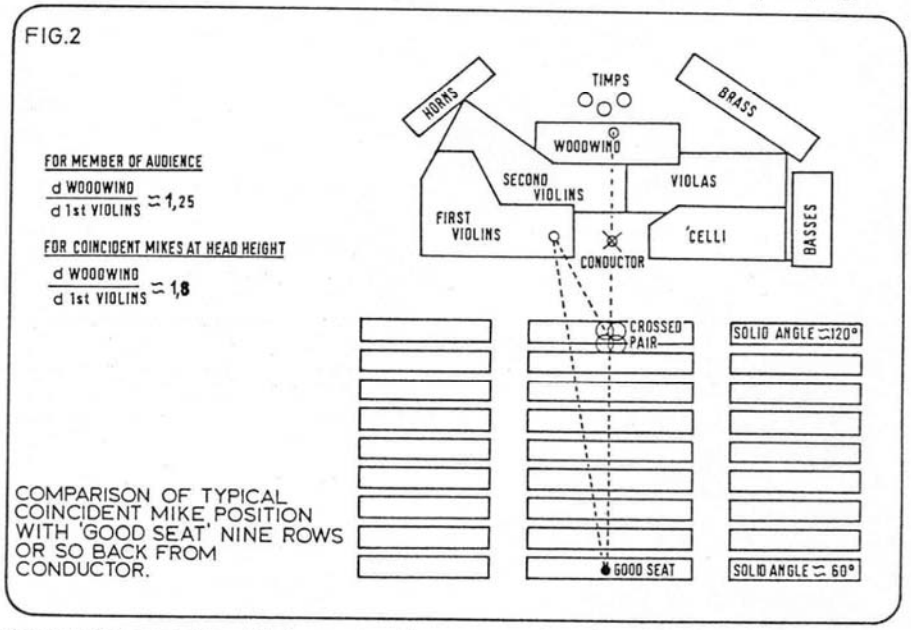


(a) TRADITIONAL CROSSED FIGURE-OF-EIGHTS



(b) PARALLEL FIGURE-OF-EIGHTS
(Not to scale: spacing approx. 200mm)

FIG.2



COMPARISON OF TYPICAL COINCIDENT MIKE POSITION WITH 'GOOD SEAT' NINE ROWS OR SO BACK FROM CONDUCTOR.

Moving away from crossed figure-of-eights as far as 70% of commercial jobs are concerned (most engineers would put the percentage higher), the professional is left to his wits but then rapidly incurs the wrath of the academics, most of whom seem to favour a scientific model of stereo perception where the human head is infinitely small and has only one multidirectional spherical ear—this may be true for them, but it is certainly not the case for most of us.

The communication of a sense of 'space' and ambience is a primary objective for most classical engineers because it is of great worth in the conveying of the 'illusion' of a concert-hall performance to the listener, and will help put him at his ease for the enjoyment of music in the artificiality of his front-room. In my experience this sense of space is rarely if ever communicated by the use of a pure single-point coincident pair of microphones, other than 90° figure-of-eights in exceptional halls, and I feel it important, therefore, to re-examine the hearing-model involved. For around 10 years, the overwhelming majority of my own recording work has been with a simple single pair of microphones, but in at least 90% of cases I have chosen intentionally to space the microphone capsules by a few centimetres. The amount of 'air' let into a sound-balance by spacing capsules even such a small amount is quite surprising, and is most constructive in producing a more realistic illusion of the hall ambience.

Even back in 1931 Alan Blumlein's patent proposed that the operation of the ears in determining the direction of a sound source is not yet fully known but it is fairly well established that the main factors having effect are phase differences and intensity differences between the sounds reaching the two ears... etc'. By adopting a pure single point coincident microphone system, with the arguable exception of crossed figure-of-eights, one is intentionally integrating out the 'inter-ear' phase differences by sampling at one point only and limiting one's image reproduction essentially to amplitude differences.

A closer investigation of the reasons for opting originally for 'absolute coincidence' reveals in my opinion only two significant points in its favour: firstly, the mechanical convenience of being able to mount directional capsules in a single housing as a stereo microphone (fig. 3); and secondly, the ease with which the theoreticians can control the complexity of the mathematics involved in attempting to analyse the function of a stereophonic recording system. As a professional engineer, my job is to produce recordings which make some attempt to communicate the atmosphere of a concert performance, and I fear I see no particular merit in opting for a particular microphone technique purely to make life easier for the mathematicians—that seems to me like putting the cart before the horse! To my ears pure coincidence produces too often an 'in